

STATUS REPORT NO. 12 - NGR-03-003-001
January 1, 1969 thru June 30, 1969

PURPOSE OF GRANT

Studies in planetology, including the collection and interpretation of planetary information.

PERSONNEL

W. A. Baum, Director
R. L. Millis, Assistant Astronomer
T. Pettauer, Assistant Astronomer, part-time
B. Q. Faure, Observer and Film Analyst
D. T. Thompson, Observer and Film Analyst, from February 17
H. S. Horstman, Research Assistant and Secretary
K. Rost, Electronics Engineer
J. H. Chastain, Electronics Technician
M. B. Zytowski, Mechanical Designer, from June 30
N. G. Dales, Instrument Maker, until May 14
H. Culp, Instrument Maker, until February 21
N. O. Cook, Photographic Assistant
R. Penland, Photographic Assistant
L. Colley, Maintenance, part-time
H. L. Giclas, Administration, part-time
H. J. Scheele, Administration, part-time
L. Wiebe, Summer Assistant, from May 27
B. Hyde, Summer Assistant, from June 6

In addition to the preceding staff funded under NGR-03-003-001, there are several people with separately-funded salaries working directly on Planetary Research Center projects. These include S. E. Jones, Chief Technician, J. L. Loven, Business Manager (part-time), L. J. Martin, Plate Analyst, G. E. Fischbacher, Plate Analyst, C. E. Laughead, Computer Programmer (part-time), D. G. Tye, Cataloguer-Secretary (through May 16), and D. P. Ingram, Laboratory Assistant (from June 1).

ORGANIZATION AND DISTRIBUTION OF PHOTOGRAPHIC MATERIAL

Under the supervision of Stuart Jones, much of the time of the photographic laboratory during this report period was devoted to work associated with the Planetary Patrol Program, which is the largest current project at the Planetary Research Center. This work has particularly included the sensitometric calibration and the processing of Planetary Patrol films

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that are currently being received at the Planetary Center in large numbers. The rest of the time of the photographic laboratory has been devoted to the testing of emulsions, the photographing of equipment, the making of slides and prints, and the filling of various outside requests for copies from the collection.

During the past few months the photographic processing equipment has been used more continuously than before, and it has been difficult to hold the temperature down. To help cope with this, the Observatory's water tank has been painted with titanium oxide paint and a cooling system is currently being installed to pull the darkroom temperature down.

The checking and cataloguing of the Lowell copies has been continued by Helen Horstman. During the particular six months covered by this report, 4,524 films (two from each original plate) have been sent to the IAU Data Center at Meudon Observatory, while two similar films have been retained here. Observation notes for the collection were organized and put into easily accessible form by Darlene Tye. These notes dated back to 1907.

Two special projects were initiated and completed. The IBM 1130 computer was used in preparing a copy of the ephemeris printout of our complete IAU Mars collection for the Viking Project Office, NASA-Langley Research Center, Hampton, Virginia. Three batches of contact copies (400, 215, and 25) of original Mars plates were loaned to New Mexico State University Observatory.

The Planetary Research Center is frequently called upon to supply photographs and technical information relative to the planets for use by publishers and various institutions. During this report period, eighteen such requests were filled.

During this report period, 34 film copies (two copies of 17 films) of Venus composite positives were received from the IAU Data Center at Meudon, and 358 film copies (two each of 179 composites) of Mars composite positives were received from Table Mountain Observatory. Approximately 2,000 data cards for various planetary observations were received from New Mexico State University Observatory. This information is in the process of being punched onto IBM cards and added to the IAU card catalogue. IBM data cards for the entire Venus and Saturn IAU collection were furnished New Mexico.

PLANETARY PATROL PROGRAM

Not only is the Planetary Patrol Program the largest single undertaking of the Planetary Research Center, but during the last few months it has almost completely absorbed the time and energy of the entire Planetary Center staff. This program is being described in a separate

status report (No. 2 under NGR-03-003-007), so the details of the patrol program will not need to be covered here in this report. Administrative responsibilities have been shared by Baum, Loven, and Jones. Several non-Planetary-Center people at Lowell made substantial contributions as described in the patrol report. As time goes along, we expect the patrol program pressure to slacken a little, but the patrol will almost certainly continue to be our largest task.

The purpose of the Planetary Patrol Program is to obtain photographic observations of the planets during the next few years with much greater continuity than has heretofore been possible from any one observatory. Six observatories (including Lowell) distributed in longitude around the Earth are participating. The observations are being made on 35-mm film with identical planetary camera systems that are provided with electronically controlled sequencing and that automatically record the place, date, time, and color of each photograph directly on the film. Two new telescopes have been installed (Chile and Hawaii), a third has been modernized, and optics for a fourth have been made. Color-correcting lenses have been designed, made, and installed in two existing refractors (Australia and South Africa). All of the telescopes have been either designed or modified to produce a focal length of approximately 1800 inches so that the image scales are all 4.5 arc-seconds per millimeter.

Most of the patrol network started taking observations about three months ago. At Lowell Observatory, two telescopes have been continuously manned by a team of four observers including Martin, Fischbacher, Faure, and Thompson. The films from all stations are being sent to the Planetary Research Center at Lowell Observatory for calibration, processing, editing, copying, and systematic analysis. More than 10,000 sequences of exposures have thus far been processed, and a substantial percentage of these are of readable quality. After editing has been completed, copies of films in roll form can be obtained at cost by anyone desiring them.

PLANETARY OBSERVATIONS

Most of the photographic observations made during this report period at Lowell Observatory were related to the patrol program that has just been described. These included roughly 80 nights at each of the two telescopes. However, in June a separate project was carried out by Baum and Jones at the Perkins 72-inch telescope to gather Mars photographs suitable for later image-restoration (spatial filtering) experiments. From preliminary attempts with images of typical size and granularity in the present collection, we had found that images of very much higher grain-information content would be needed before spatial filtering could be applied without an objectionable increase in image noise. We therefore operated the Perkins telescope at full aperture, used a Barlow lens

to produce as large an image as the frame size of our prototype camera would permit, and exposed in long uninterrupted sequences so as to record as many grains per image element per unit time as possible. In due course, these "high information content" images will provide ideal material for further experiments in compositing and spatial filtering.

Photoelectric scans of Mars were made by Boyce with the new Lowell-Tololo patrol telescope in Chile. A dual-channel area scanning photometer was mounted alongside the planet camera in such a way that scans could be conveniently made during time intervals between the patrol observations. The scanner used a dichroic mirror and two photomultipliers together with interference filters for comparing intensity profiles of the Martian disk at two wavelengths, one fixed at 6000\AA , and the other at each of eight wavelengths between 3300\AA and 5200\AA . These scans permitted the spectral albedo of the Martian clouds and polar hood to be compared with those of light and dark markings on the planet's surface. These scans show that the clouds and polar hood are essentially "white," and that some of the surface features undergo interesting changes in color with time. These observations extended over a two-month period beginning in May and will require extensive analysis.

Photoelectric observations of the brightness of the Galilean satellite Io during eclipse reappearance were initiated in 1967 by Rakosch and Millis. These were continued by Franz, Pettau, and Millis during the 1969 apparition of Jupiter. As mentioned in Status Report No. 11, Io had been reported by others to undergo a temporary brightening as it emerged from eclipse. Our present observations show no such brightening, and they are of an accuracy that clearly negates the existence of any such effect.

More polarimetric scans of Saturn were made by Hall with the two-channel photometric polarimeter attached to the Perkins telescope. As before, these observations were made in the ultraviolet and visual regions, using color filters. Except possibly for the equatorial zone, the polarization vectors were found to lie in a radial direction, as Hall had also found earlier for Jupiter.

PLATE STUDIES

One of three major plate studies at the Planetary Center was completed during this report period, and a final report was submitted. This work concerned the seasonal behavior of the Martian polar caps, and it was based on more than 3,000 yellow and red photographs obtained between 1905 and 1965. The boundaries of the caps were read by Martin and Fischbacher at intervals of ten degrees in longitude on the Martian surface, and the data were averaged over time intervals equal to $1/36$ of the Martian year. Readings were entered directly onto IBM cards by

the "mark sense" method, and computer programs were written to organize the results into the form of tabulations and plots. The receding phase of each cap was found to follow a well-defined curve that repeated itself quite closely from one Martian year to another. During that phase for the south cap, the mean deviations of measurements from various plates were only one or two degrees, and the variation from one Martian year to another was of similar magnitude. The influence of local topography and/or surface material can be detected by noting differences in behavior from one meridian to another during the recession of the south cap.

Another one of the plate studies was also completed by Martin during this report period, and the final report is almost finished. This study was concerned with Martian cloud motions. A search of the complete plate collection yielded 28 groups of Mars plates on which the local positions of well-defined clouds or groups of clouds could be followed on a daily basis. These groups of plates were from fifteen different oppositions of Mars, starting from 1907 and ending with 1958. Each group of plates covered a time period of at least two days and up to 29 days. The position and extent of associated clouds were plotted on Mercator projections. A separate map was prepared for each of the 28 cloud groups showing an average daily position for each cloud. Some of the maps indicate notable cloud movement, while others show long periods of no significant motion. There are not yet enough cloud velocity vectors to establish a complete pattern of atmospheric circulation, and this is one of the major problems to which the Planetary Patrol Program can contribute.

The third plate study mentioned in Status Report No. 11 was concerned with the general distribution of cloudiness and haze on Mars. The reading of data, mostly by Fischbacher, had been completed last year, and some parameters for describing the results have been previously discussed. During the present report period, we have tried a new method of mapping in which the data are reduced by the computer to shaded tones on a Mercator projection. Although a complete set of such maps now exists, we are not yet completely satisfied with the result and want to continue working on it.

GUEST INVESTIGATORS AND VISITORS

In January, Bradford Smith, James Robinson, and Scott Murrell of New Mexico State University made a multi-purpose visit to the Planetary Center. Robinson examined a large number of Mars films and selected about 400 to take with him for making copies at New Mexico. Smith and Murrell familiarized themselves with the planetary cameras, including actual use of the prototype camera on the Lowell 24-inch refractor. This work was in preparation for Murrell's trip to Australia to serve as a patrol observer at Mount Stromlo.

In January and again in May, Charles F. Capen of the Table Mountain Observatory used our planetary image projector for reading data from Mars photographs that he brought with him from California.

In May, Dr. I. S. Bowen, former director of the Mount Wilson and Palomar Observatories, made another of his several visits here to advise us on optical problems. Don Loomis of Tucson was also here during Bowen's visit to discuss some components that he will be making to Bowen's design.

In June, Robinson and Smith of New Mexico State University were again here to examine Mars films and select some to take to New Mexico with them. Smith also delivered some data cards concerning plates at New Mexico that will be entered in the IBM card catalogue here.

In June, the Astronomical Society of the Pacific held its annual scientific meeting here at the Planetary Research Center. About 100 astronomers attended. In addition to the usual sessions for papers, there was a symposium on pulsars. Various aspects of the work here at the Planetary Center were described and were on exhibit.

Dr. de Vaucouleur devoted some time to examining material in the plate collection in connection with his mapping project.